CLAIMS

1. A method comprising displaying an image of a navigation object in a head-up display of a vehicle wherein the image of the navigation object is displayed to an observer volumetrically and with continuous depth.

2. The method of claim 1 wherein the navigation object is in the form of at least one cable.

3. A method comprising displaying an image of at least one cable superimposed over a view of a landscape in such a way that the cable appears to an observer of the cable to be a real object existing in the landscape higher than the head of the observer.

4. A method comprising displaying an image of at least one cable superimposed over a view of a landscape in such a way that the cable appears to an observer to be at a height of about 3 – 20 meters above the surface of the landscape, said height being substantially uniform at any particular point in time, and said height being substantially uniform including where the surface of the landscape is other than substantially flat.

5. A method comprising displaying an image of at least one cable superimposed over a view of a landscape in such a way that the image of the cable is displayed to an observer with an optic flow that is consistent with the optic flow of the landscape when the observer moves relative to the landscape and wherein the cable appears to the observer to be at a height of about 20 meters or less above the surface of the landscape.

6. A method comprising displaying an image of at least one continuous cable superimposed over a view of a landscape and indicating a route to be followed, wherein the cable appears to an observer to be at a height of about 20 meters or less above the surface of the landscape.

7. A method comprising displaying an image of at least one cable on a head-up display within a vehicle in such a way that the image of the cable is superimposed over landscape viewed by an observer within the vehicle, the cable appearing to extend out in front of, and away from, the vehicle,

the image of the cable being displayed volumetrically and with an optic flow that is consistent with the optic flow of the landscape when the vehicle is moving.

8. A method for use in an automobile or other motor vehicle that travels only on the surface of the earth, the vehicle having installed therein a head-up display capable of displaying images volumetrically to an observer who is a driver of the vehicle, the image being superimposed over landscape that is within the field of view of the driver, the method comprising

determining a route for the vehicle,

computing data that controls the head-up display in such a way as to display to the observer an image of a cable that appears to the observer to be extending forwardly away from the vehicle on the route at a height that the

volumetric display causes to appear to the observer to be between about 3 meters and about 20 meters above the surface, and

repeating the computing at successive time intervals in such a way that the cable appears to the observer to be substantially stationary relative to the landscape even when the vehicle is moving.

9. A method comprising displaying an image of a navigation object in a head-up display of a vehicle that is adapted to travel exclusively on the surface of the earth wherein the navigation object is displayed volumetrically to an observer and wherein the navigation object is a cable in the form of one of a) a continuous line, b) a continuous line having segments that have a different luminance from the rest of the line, c) a line with non-closely-spaced gaps, or d) a string of closely-spaced objects.

10. The method of either of claims 7 or 9 wherein the image of the cable is displayed within a vehicle and wherein the cable appears to the observer to be positioned at a particular distance above the surface.

11. The method of any of claims 2 through 5 further comprising calculating a route to a destination from a present location of the observer, the image of the cable being displayed in such a way that the cable appears to the observer to be on the route.

12. The method of any of claims 7 through 9 further comprising calculating a route to a destination from a present location of the observer, the image of the cable being displayed in such a way that the cable appears to the observer to be on the route.

13. The invention of either of claims 11 or 12 wherein the method is performed by apparatus within a vehicle.

14. The invention of claim 13 wherein

the route includes at least one roadway, and

the route is calculated in response to a) stored data that contains information about roadways over which the vehicle may travel and b) data indicating the present position of the vehicle.

15. The invention of claim 14 wherein the information about roadways includes information that was generated from other vehicles as to the location of the roadways, said generated information having been reported from the other vehicles to at least one central database.

16. The invention of either of claims 11 or 12 wherein

the route includes at least one roadway, and

the cable appears to the observer to be at a substantially uniform distance above the surface of the roadway including where the surface of the roadway is other than substantially flat.

17. The invention of claim 16 wherein the cable appears to the observer to be in a substantially fixed relation to the roadway including where the roadway is other than straight.

18. The invention of either of claims 11 or 12 further comprising

calculating an alternate route to the destination, and

displaying an image of at least one alternate cable superimposed over the view of the landscape, that image being displayed in such a way that it appears to the observer to be on the alternate route.

19. The method of either of claims 11 or 12 wherein the displaying includes

repetitively re-calculating how the image of the cable is to be displayed based on the calculated route and further based on the then present position of the observer, and

displaying each recalculated image of the cable.

20. The method of claim 11 further comprising repetitively re-displaying a new version of the image of the cable based on movements of the observer.

21. The method of claim 20 wherein the method is performed by apparatus within a vehicle and wherein the re-displaying is further based on at least one signal received from at least one sensor in said vehicle.

22. The method of claim 12 further comprising repetitively re-displaying a new version of the image of the cable based on movements of the observer.

23. The method of claim 22 wherein the method is performed by apparatus within a vehicle and wherein the re-displaying is further based on at least one signal received from at least one sensor in said vehicle.

24. The method of any of claims 3 through 6 wherein the image of the cable is displayed on a head-up display and wherein the view of the landscape is the landscape seen directly by the observer through the head-up display.

25. The method of claim 24 wherein the head-up display is disposed in a vehicle that travels exclusively on the surface of the earth.

26. The method of claim 24 wherein the head-up display is disposed in a motor vehicle and the observer is the driver of the motor vehicle.

27. The method of any of claims 2, 3, 7 or 9 wherein the cable appears to the observer to be about between 3 to 20 meters above the surface of the landscape.

28. The method of any of claims 2, 3 or 5 through 9 wherein the cable appears to the observer to be about 10 meters above the surface of the landscape.

29. The method of any of claims 3, 4, 6, 8 or 9 wherein the image of the cable is displayed with an optic flow that is consistent with the optic flow of the landscape when the observer moves relative to the landscape.

30. The method of any of claims 3, 4, 6, 8 or 9 wherein the image of the cable is displayed in such a way that when the observer is moving the cable appears to the observer to be substantially stationary relative to the landscape .

31. The method of any of claims 3 through 6 wherein the image of the cable is displayed to the observer volumetrically.

32. The invention of any of claims 2 through 9 wherein the image of the cable is displayed in such a way that light rays comprising the image of the cable appear to the observer substantially as would light rays that originated from a real cable extending forwardly away from the observer.

33. The method of any of claims 3 through 8 wherein the image of the cable is displayed by a display apparatus in such a way that light rays comprising the image of the cable that reach the observer appear to the observer to be light rays that originated from a real object existing in the landscape.

34. The method of any of claims 3 through 9 wherein the image of the cable is displayed with at least one depth cue.

35. The method of claim 34 wherein the at least one depth cue is perspective.

36. The method of claim 34 wherein the at least one depth cue is stereoscopic disparity.

37. The method of claim 34 wherein the at least one depth cue is motion parallax.

38. The method of claim 34 wherein the at least one depth cue is focus.

39. The method of claim 34 wherein the at least one depth cue is convergence.

40. The method of claim 34 wherein the at least one depth cue is dimming.

41. The method of any of claims 2 through 5, 7, 8 or 10 through 40 wherein the at least one cable comprises a continuous line.

42. The method of any of claims 2 through 5, 7, 8 or 10 through 40 wherein the at least one cable comprises a line with non-closely-spaced gaps.

43. The method of any of claims 2 through 5, 7, 8 or 10 through 40 wherein the at least one cable comprises a line having non-closely-spaced segments that have a different luminance from the rest of the line.

44. The method of any of claims 2 through 5, 7, 8 or 10 through 40 wherein the at least one cable comprises a string of closely-spaced objects.

45. The method of any of claims 2 through 9 or 10 through 40 wherein there are at least two of the cables.

46. The method of any of claims 2 through 45 wherein the cable includes markers that appear to be moving along the cable at a selected speed.

47. The method of any of claims 2, 10, 19, 20 or 21 wherein the image of the cable is displayed within a vehicle, wherein the observer is the driver of the vehicle and wherein the cable appears to the driver to be positioned higher than the head of the driver when the driver is operating the vehicle.

48. The method of any of claims 7, 9 or 13 through 18 wherein the observer is the driver of the vehicle and wherein the cable appears to the driver to be positioned higher than the head of the driver when the driver is operating the vehicle.

49. The method of either of claims 47 or 48 wherein at least a first point in time the image of the cable is displayed to a driver of a vehicle in such a way that the cable appears to the observer to be positioned aligned with the head of the driver even if the head of the driver is not on the calculated route.

50. The method of claim 49 wherein said at least a first point in time is when a driving session commences.

51. The method of claim 49 wherein said at least a first point in time is when the location of the vehicle is not known to a particular level of accuracy.

52. The method of and of claims 49 through 51 wherein if the vehicle subsequently moves and remains out from under the apparent position of the cable for a selected period of time, the image of the cable is displayed to the driver in such a way that the cable again appears to the observer to be positioned aligned with the head of the driver.

53. The method of any of claims 2 through 52 wherein the image of the cable is displayed in a vehicle that includes a collision avoidance system that automatically steers the vehicle when a collision is imminent and wherein the method further comprises displaying the image of the cable in such a way that the cable appears to the observer to extend along a route that the collision avoidance system is steering the vehicle on.

54. The invention of any of claims 3 through 53 wherein the cable is displayed without any accompanying images that correlate points on the cable with locations in the landscape.

55. Apparatus adapted to be installed in a vehicle, said apparatus comprising
means for determining a present location of said vehicle on the surface of the earth,
means for computing a route for said vehicle from the present location to a destination,
a head-up display, and
means for controlling the head-up display in such a way as to display a cable using the method of any of claims 2 through 54.

56. Apparatus adapted to display an image of a navigation object in a head-up display of a vehicle wherein the image of the navigation object is displayed to an observer volumetrically and with continuous depth.

57. Apparatus adapted to display an image of at least one cable superimposed over a view of a landscape in such a way that the cable appears to an observer of the cable to be a real object existing in the landscape higher than the head of the observer.

58. Apparatus adapted to display an image of at least one cable superimposed over a view of a landscape in such a way that the cable appears to an observer to be at a height of about 3 – 20 meters above the surface of the landscape, said height being substantially uniform at any particular point in time, and said height being substantially uniform including where the surface of the landscape is other than substantially flat.

59. Apparatus adapted to display an image of at least one cable superimposed over a view of a landscape in such a way that the image of the cable is displayed to an observer with an optic flow that is consistent with the optic flow of the landscape when the observer moves relative to the landscape and wherein the cable appears to the observer to be at a height of about 20 meters or less above the surface of the landscape.

60. Apparatus adapted to display an image of at least one continuous cable superimposed over a view of a landscape and indicating a route to be followed, wherein the cable appears to an observer to be at a height of about 20 meters or less above the surface of the landscape.

61. Apparatus adapted to display an image of at least one cable on a head-up display within a vehicle in such a way that the image of the cable is superimposed over landscape viewed by an observer within the vehicle, the cable appearing to extend out in front of, and away from the vehicle,
the image of the cable being displayed volumetrically and with an optic flow that is consistent with the optic flow of the landscape when the vehicle is moving.

62. Apparatus for use in an automobile or other motor vehicle that travels only on the surface of the earth, the vehicle having installed therein a head-up display capable of displaying images volumetrically to an

observer who is a driver of the vehicle, the image being superimposed over landscape that is within the field of view of the driver, the apparatus comprising

means for determining a route for the vehicle,

means for computing data that controls the head-up display in such a way as to display to the observer an image of a cable that appears to the observer be extending forwardly away from the vehicle on the route at a height that the volumetric display causes to appear to the observer to be between about 3 meters and about 20 meters above the surface, and

means for repeating the computing at successive time intervals in such a way that the cable appears to the observer to be substantially stationary relative to the landscape even when the vehicle is moving.

63. Apparatus adapted to display a navigation object in a head-up display of a vehicle that is adapted to travel exclusively on the surface of the earth wherein the navigation object is displayed volumetrically to an observer and wherein the navigation object is a cable in the form of one of a) a continuous line, b) a continuous line having segments that have a different luminance from the rest of the line, c) a line with non-closely-spaced gaps, or d) a string of closely-spaced objects.

64. A method of navigation of a motor vehicle traveling on a roadway, wherein a route to a desired destination is indicated by a virtual optical image seen by an operator of said vehicle substantially in front of said vehicle, wherein said virtual optical image is in a form of a luminous spot and wherein said virtual optical image moves along a three-dimensional path, said path being positioned at least in part substantially in front and above of said vehicle, from 3 to 20 meters above the roadway and substantially parallel to the centerline of said roadway, and wherein the movement of said virtual optical image is sufficiently fast as to cause, because of the persistence of human vision, said virtual optical image perceived by the operator of said vehicle to be an extended object, extending along said path.

65. The method of claim 64 wherein said virtual optical image is produced periodically and frequently enough to cause the image perceived by the operator of said vehicle to be continuously present.

66. The method of claim 65 wherein said virtual optical image is produced in a moving vehicle and wherein said virtual optical image is, in some part of its travel, traversing substantially the same path relative to the roadway, despite of the movement of the vehicle, thus to cause the image perceived by the operator of said vehicle to be stationary relative to said roadway.

67. The method of claim 64 wherein said virtual optical image is an image of a real bright source seen through viewing optics of a display apparatus, said apparatus being able to change the optical distance of said virtual optical image from said operator of said vehicle by continuously adjusting the position of said real bright source in relation to said viewing optics of said optical apparatus.

68. The method of claim 67 wherein said viewing optics allow the operator of said vehicle to see said virtual image with both eyes at the same time.

69. The method of claim 68 wherein said viewing optics have an exit pupil large enough to accommodate both eyes of said operator.

70. The method of claim 67 wherein said real bright source is an illuminated spot created by shining a laser beam onto a diffusive screen, said laser beam being steerable by a computer executing software.

71. The method of claim 70 wherein said adjusting the position of said real bright source is effected through continuous actuation of said diffusive screen by an actuator steered in real time by a computer executing software, so steered in coordination with any movements of said illuminated spot relative to said diffusive screen, said movements caused by changes in a position of said laser beam under control of a computer executing software.

72. The method of claim 70 wherein said screen is actuated by voice-coil-type device.

73. The method of claim 70 wherein said screen is other than flat.

74. The method of claim 70 wherein said screen is concave.

75. A method of navigation of a motor vehicle traveling on a roadway, wherein a route to a desired destination is indicated by a virtual optical image seen by an operator of said vehicle substantially in front of said vehicle, wherein said virtual optical image is in form of a line having a discernible width and having visibly well defined edges, the perceived width of the line by the operator of the vehicle being less than 3 degrees of angle.

76. The method of claim 75 wherein at least part of said line is presented as extending away from said operator in three dimensions, and wherein any portion of said line which is farther away from said operator than some other portion of said line has smaller angular thickness than that other portion of said line, substantially in agreement with laws of perspective, except when such other portion of said line has angular diameter as small as an apparatus can display, in which case perception of further thinning of said line with growing distance is effected through gradually diminishing of said line perceived luminance with growing distance in agreement with laws of perspective.

77. The method of claim 76 wherein the perceived luminance of said line varies across its width in a fashion gradually controlled along its lengths, as to imbue said line with a perceived luminance profile reminiscent of a glowing translucent rod.

78. The method of claim 64 wherein said virtual optical image is an image of a real bright source seen through viewing optics of a display apparatus, said viewing optics having longitudinal chromatic aberration, said apparatus being able to change the optical distance of said virtual optical image from said operator of said vehicle by continuously adjusting the wavelength of light emanating from said real bright source.

79. The method of claim 78 wherein said viewing optics allow the operator of said vehicle to see said virtual image with both eyes at the same time.

80. The method of claim 78 wherein said viewing optics have an exit pupil large enough to accommodate both eyes of said operator.

81. The method of claim 78 wherein said real bright source is an illuminated spot created by shining a laser beam onto a diffusive screen, said laser beam being steerable by a computer executing software.

82. The method of claim 81 wherein said adjusting the wavelength of light emanating from said real bright source is effected through continuous wavelength tuning of at least one tunable laser in real time by a computer executing software, in coordination with any movements of said illuminated spot relative to said diffusive screen, said movements caused by changes in a position of said laser beam under control of a computer executing software.

83. The method of claim 81 wherein said adjusting the wavelength of light emanating from said real bright source is effected through continuous selection of some lasers, out of plurality of lasers, to emit light at a given moment of time, in real time by a computer executing software, in coordination with any movements of said illuminated spot relative to said diffusive screen, said movements caused by changes in a position of said laser beam under control of a computer executing software.

84. Apparatus for use in an automobile or other motor vehicle that travels only on the surface of the earth, the vehicle having installed therein a head-up display capable of displaying images to an observer who is a driver of the vehicle, the image being superimposed over landscape that is within the field of view of the driver, the apparatus comprising

a laser light source,

means for forming a beam of light,

means for modulating said beam of light, means for continuously changing direction of said beam of light, in vector graphic mode, means for continuously changing convergence of said beam of light,

a diffusion means onto which said beam of light is being shone to paint a primary image,

viewing optics, including combiner, thru which a longitudinally magnified virtual image of said primary image can be observed with both eyes at the same time, and

means for continuously changing optical distance of said virtual image.

85. The apparatus of claim 84 further comprising means for continuously changing spherical aberration of said beam of light.

86. The apparatus of either of claims 84 or 85 wherein said means for continuously changing optical distance of said virtual image comprises means for continuously adjusting the position of said diffusion means relative to said viewing optics.

87. The apparatus of either of claims 84 or 85 wherein said means for continuously changing optical distance of said virtual image comprises means for continuously adjusting the wavelength of light of said laser light source and said viewing optics having longitudinal chromatic aberration.

88. Apparatus for use in an automobile or other motor vehicle that travels only on the surface of the earth, the vehicle having installed therein a head-up display capable of displaying images to an observer who is a driver of the vehicle, the image being superimposed over landscape that is within the field of view of the driver, the apparatus comprising

a laser light source, means for forming a beam of light, means for modulating said beam of light, means for continuously changing direction of said beam of light, in vector graphic mode, means for continuously changing convergence of said beam of light,

a diffusion screen onto which said beam of light is being shone to paint a primary image, and

viewing optics, including combiner, thru which a longitudinally magnified virtual image of said primary image can be observed with both eyes at the same time,

wherein said diffusion screen is in tilted position relative to optical axis of said viewing optics.

89. The apparatus of claim 88 further comprising means for continuously changing spherical aberration of said beam of light.

90. Apparatus adapted to display a luminous image of a cable on a head-up display within a vehicle in such a way that the image of the cable is superimposed over landscape viewed by an observer within the vehicle, the cable appearing to extend out in front of, and away from the vehicle, the cable appearing to be about between 3 to 20 meters above the surface of the landscape and to follow the surface underneath it vertically, the image of the cable being displayed with depth cue of stereoscopic disparity and with depth cue of motion parallax induced by head movements of the observer, and the image of the cable being displayed with an optic flow that is consistent with the optic flow of the landscape when the vehicle is moving as to cause the cable to appear to the observer to be substantially stationary relative to the landscape.

91. The apparatus of claim 90 further comprising an internal diffusive projection screen, wherein said screen is moveable under control of a computer executing software.